Weekly Updates – Vinayak Gajendra Panchal

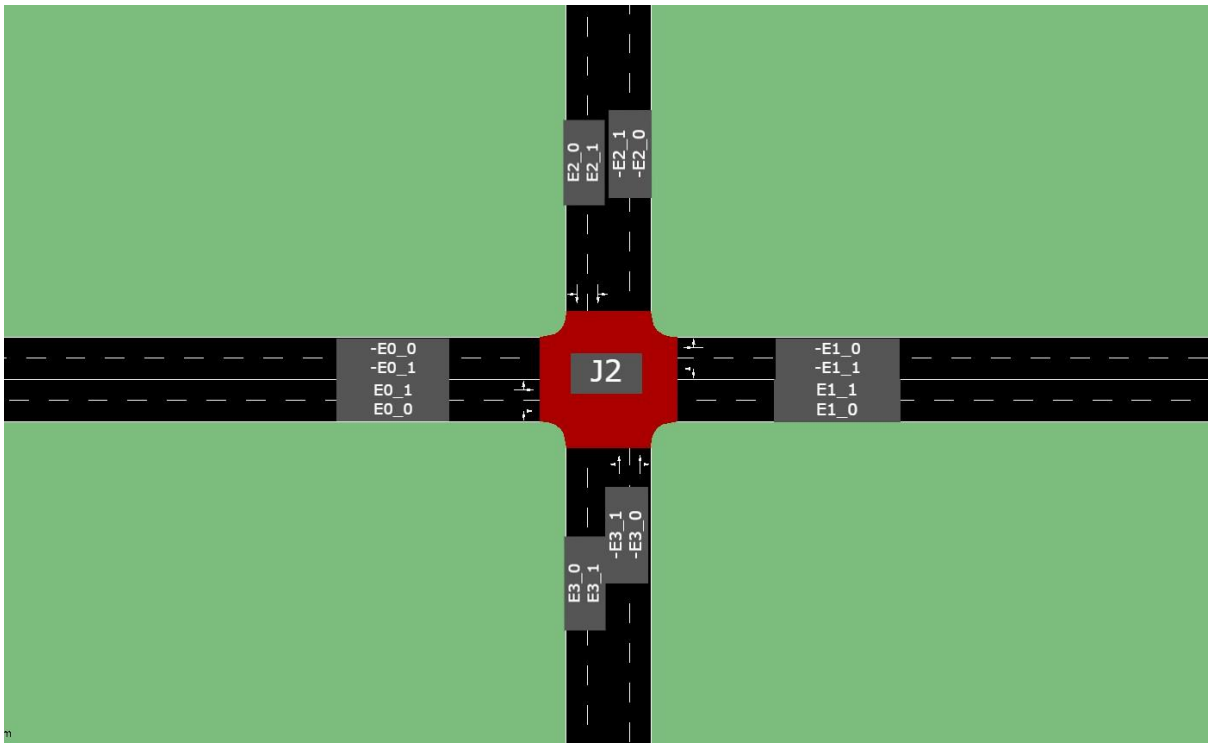
STUDY:

1. The recommended average maximum deceleration rates specified in ITE's 2009 guidelines are 3.0 m/s², while AASHTO's 2004 guidelines suggest a slightly higher value of 3.4 m/s² for cars [1].
2. An investigation determined that the average acceleration of a passenger car falls within the range of 0 to 40.3 km/h, with a calculated value of 1.44 m/s² [2].
3. Passenger vehicles exhibit an average acceleration of 60 mph per 5 seconds, which translates to 12 mph per second, equivalent to +0.55 g's, or 5.4 m/s² [3].
4. Regardless of the final speed, the study's findings indicate an average acceleration rate of 0.14 g [4].
5. Sports cars, on average, decelerate at a rate of 5.5 m/s².

Simulation setup:

Step-length	0.10 sec (10 cycles/sec)
Collision.action	remove
Collision.stoptime	0 sec
Collision.check-junctions	True
'- - log' (simulation log files)	simulation_main.log
Number of Vehicles	100
Number of simulations per param	6

2-Lane 4-Way Junction Details:



Realistic values of the parameters:

Based on the study I decided on these parameter values for the study.

maxSpeed	41.67 m/s (150 kmph)
accel	1 to 6 m/s2
decel	3 to 6 m/s2 (case: sports car = 9/10)
sigmaerror	0.1, 0.2,0.5
tau	0.05, 0.1, 0.5,1
jmDriveAfterRedTime	3,4 s
jmDriveAfterRedSpeed	5 m/s, 10 m/s
jmDriveAfterYellowTime	3,4 s
lcCooprative	0, -1
lcSpeedGain	5, 10
minGap	1, 2.5, 5
emergencyDecel	decel+0, decel+1, decel+2

EXP 1: Parameter Impact and Their Collaborative Dynamics

1.1 Accel and Decel

Tested these values for the overall experiments to check the effects of other parameters on accel and decel.

accel	decel	Inference/reason
1	3	Normal passenger vehicle with slow accel and decel
2	3.5	Normal passenger vehicle with moderate accel and slow decel
2	4	Normal passenger vehicle with moderate accel and moderate decel
2.6	4.5	Normal passenger vehicle with moderate accel and moderate decel [default veh setting]
2.6	5	Normal passenger vehicle with moderate accel and high decel
3	5	Moderate sporty vehicle with moderate accel and high decel
3.5	6	Moderate sporty vehicle with moderate accel and high decel
4	5	Moderate sporty vehicle with high accel and high decel
5	5	Sporty vehicle with high accel and high decel
5	6	Sporty vehicle with high accel and high decel

1.2 Checking emergencyDecel effect

To check the effect of emergencyDecel I tried 3 values. maxSpeed = 41.67 m/s

emergencyDecel: [decel+0, decel+1, decel+2]

RESULTS:

1. emergencyDecel = decel+0: No collisions and emergency brakes were recorded.
2. emergencyDecel = decel+1: Got 1 emergency brake warning for acceleration and deceleration values except (accel: 2.6, decel: 4.5). No collisions were recorded.
3. emergencyDecel = decel+2: Recorded 1 collision at (accel: 1, decel: 3). Recorded at least 1 emergency brake warning at each accel and decel except (accel: 2, decel: 4). Max of 2 emergency brake warnings recorded at (accel: 4, decel: 5).

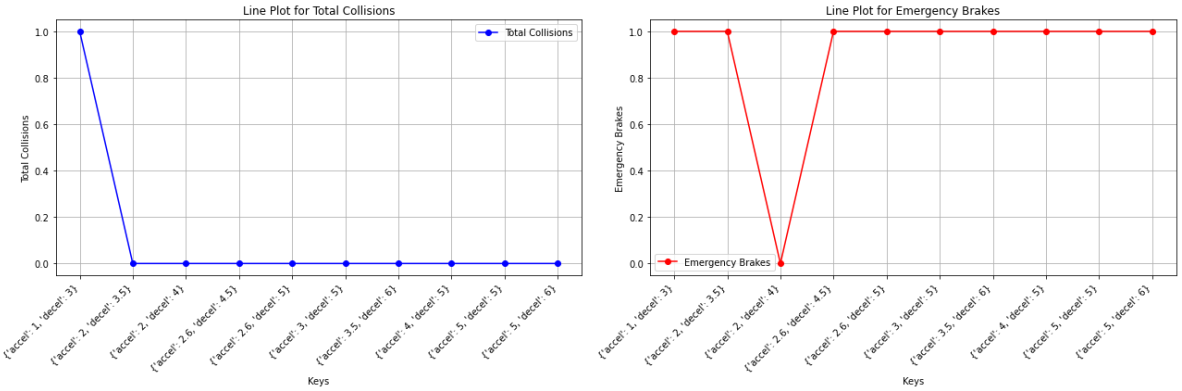


Figure 1 Total collisions and emergency brakes at emergencyDecel=decel+2

1.3 Checking sigmaerror effect:

To check the effect of sigmaerror I tried 3 values. maxSpeed = 41.67 m/s, emergencyDecel = decel+2

sigmaerror: [0.1, 0.2, 0.5]

RESULTS:

1. sigmaerror = 0.1: 1 Collision observed at (accel: 1, decel: 3) and (accel: 2.6, decel: 5). No emergency brake warning observed at (accel: 2, decel: 3.5), (accel: 2.6, decel: 4.5), (accel: 4, decel: 5), and (accel: 5, decel: 5)
2. sigmaerror = 0.2: Recorded 1 collision at (accel: 2, decel: 3.5) and (accel: 2, decel: 4). No collision was seen at other values. There was 1 emergency brake warning seen at all accel and decel.
3. sigmaerror = 0.5: Recorded 3 collisions at (accel: 1, decel: 3) and (accel: 5, decel: 5). No collision was seen at (accel: 3, decel: 5). Recorded at least 3 emergency brake warnings at (accel: 4, decel: 5) and (accel: 5, decel: 5). Minimum of 1 emergency brake warning were seen at all accel and decel.

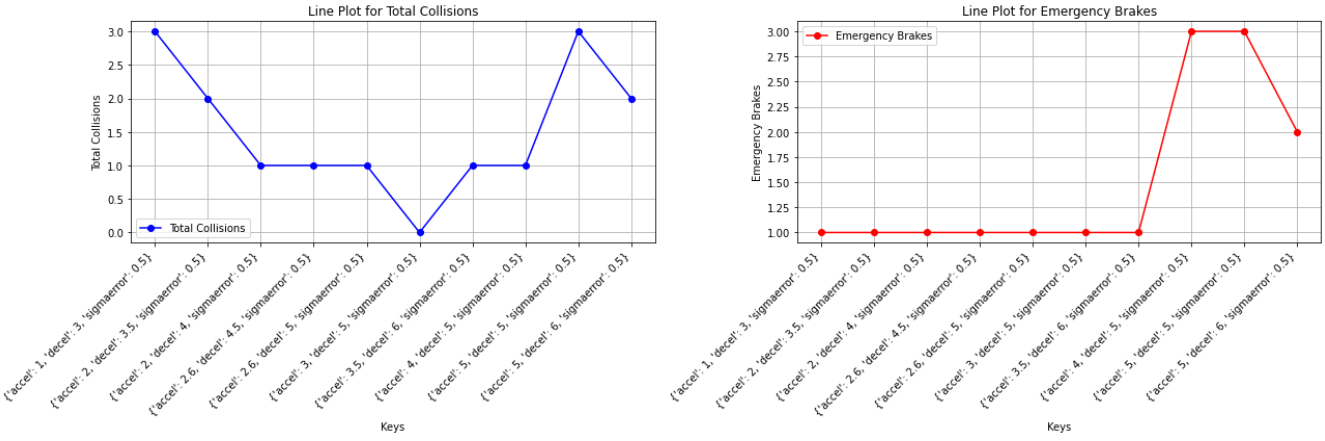


Figure 2 Total collisions and emergency brakes at sigmaerror=0.5

1.4 Checking tau effect:

To check the effect of tau tried 4 values. maxSpeed = 41.67 m/s, emergencyDecel = decel+2

tau: [0.05,0.1,0.5,1.0]

RESULTS:

1. tau = 0.05: 2 collisions were seen at (accel: 4, decel: 5), (accel: 5, decel: 5), and (accel: 5, decel: 6). No collisions were observed at (accel: 2.6, decel: 5) and (accel: 3, decel: 5). For rest accel and decel values there were on average of 1 collision. We see as the vehicles become sporty with high accel and decel values the emergency brakes value increases rapidly with peak of 38 emergency brake warnings at (accel: 5, decel: 5).
2. tau = 0.1: 2 collision was seen at (accel: 5, decel: 6). No collisions were observed at (accel: 1, decel: 3), (accel: 2, decel: 4) and (accel: 3.5, decel: 6). We see as the vehicles become sporty with high accel and decel values the emergency brakes value increases rapidly with peak of 28 emergency brake warnings at (accel: 5, decel: 5).
3. tau = 0.5: 1 collision seen at (accel: 2, decel: 3.5) and (accel: 2, decel: 4). Maximum of 2 emergency brake warning at (accel: 5, decel: 6). No emergency brake warning were observed at (accel: 1, decel: 3), (accel: 2, decel: 4), and (accel: 2.6, decel: 4.5)
4. tau = 1.0: No collisions were observed at any accel and decel combination. There were 1 emergency brake at most accel and decel combination except at (accel: 2, decel: 3.5), and (accel: 2.6, decel: 5)

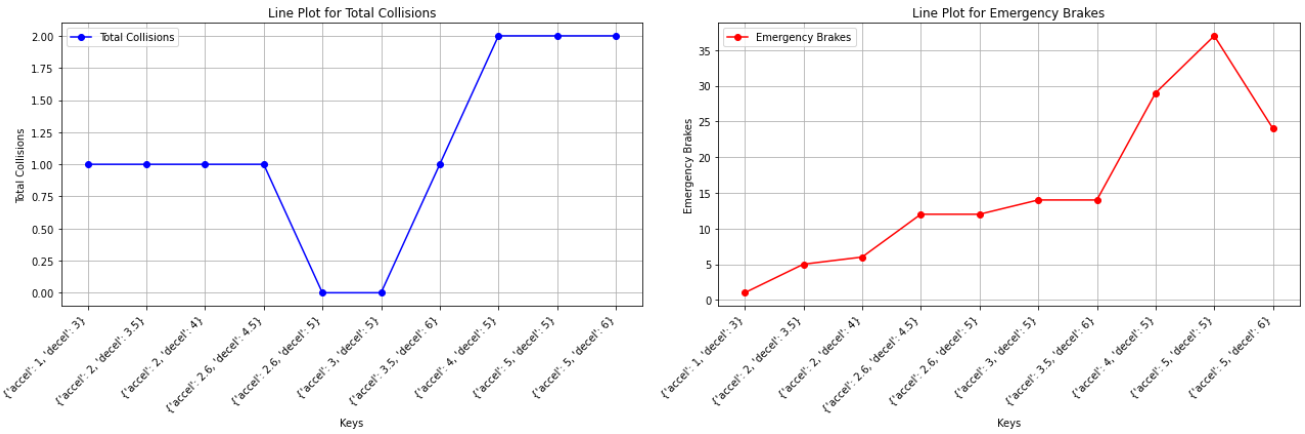


Figure 3 Total collisions and emergency brakes at tau=0.05

1.5 Checking tau and sigmaerror effect:

To check the effect of tau and sigmaerror, I tried 7 combinations. maxSpeed = 41.67 m/s, emergencyDecel = decel+2

tau: [0.1,0.5,1.0] and sigmaerror: [0.1,0.5] to check safe behavior tried (sigmaerror: 0.1, tau: 1.5)

sigmaerror	tau	Observations
0.1	0.1	Maximum of 1 collision and 24 emergency brake warnings was observed.
0.1	0.5	1 collision at (accel:1, decel:3), no collision elsewhere. 1 emergency brake warning observed at all accel and decel except (accel:2, decel:4) (accel:3, decel:5)
0.1	1.0	1 collision at (accel:5, decel:6), no collision elsewhere. 1 emergency brake warning observed at all accel and decel except (accel:2, decel:4) (accel:3, decel:5) (accel:3.5, decel:6)
0.5	0.1	Maximum of 7 collisions and 25 emergency brake warnings was observed. Collisions were maximum at higher accel and decel

0.5	0.5	Maximum of 3 collisions and 9 emergency brake warnings was observed.
0.5	1.0	At least one collision was observed and maximum of 3 collisions and emergency brake warning was encountered at (accel:1, decel:3) (accel:5, decel:6)
0.1	1.5	No collisions and emergency brake warnings were observed as it is a safe configuration.

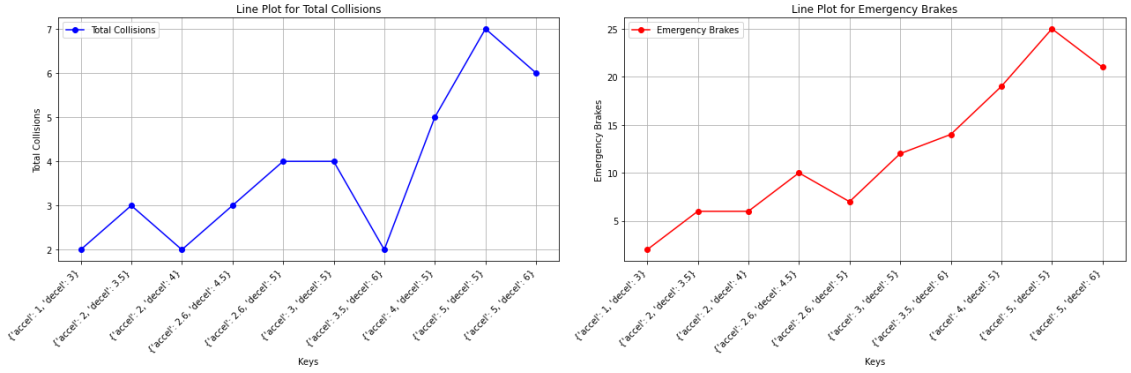


Figure 4 Total collisions and emergency brakes at sigmaerror=0.5, tau=0.1

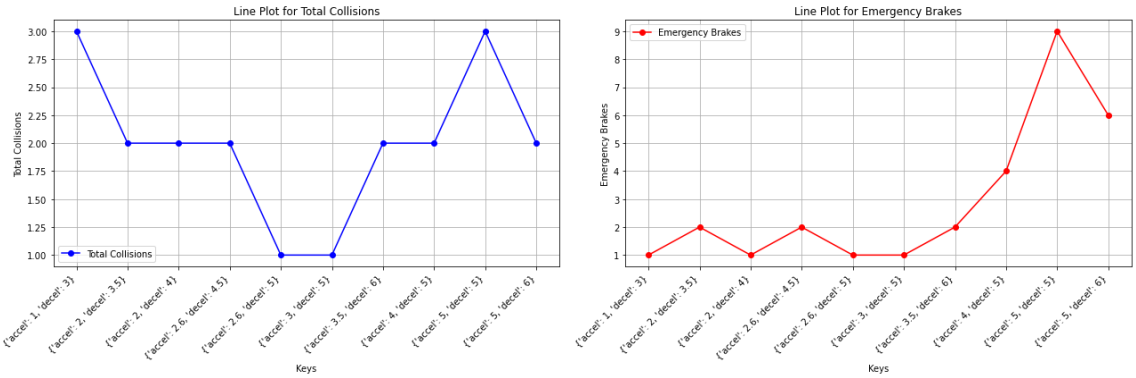


Figure 5 Total collisions and emergency brakes at sigmaerror=0.5, tau=0.5

1.6 Checking jmDriveRedSpeed and jmDriveAfterRedTime:

To check the effect, I tried 8 combinations. maxSpeed = 41.67 m/s, emergencyDecel = decel+2

jmDriveRedSpeed: [5,10] and jmDriveAfterRedTime: [3,4]

sigmaerror	tau	jmDriveRedSpeed (m/s)	jmDriveAfter RedTime (s)	Observations
0.1	1.5	5	3	No collisions were observed
0.1	0.1	10	4	Maximum of 4 collisions and 26 emergency brakes at (accel:5, decel:5)
0.5	0.1	5	3	Maximum of 8 collisions (accel:5, decel:5) and 25 emergency brakes (accel:5, decel:6)
0.5	0.1	5	4	Higher number of collisions and brakes observed at higher accel and decel.
0.5	0.1	10	3	Maximum of 7 collisions and 20 emergency brakes at (accel:5, decel:5)
0.5	0.1	10	4	Maximum of 8 collisions (accel:5, decel:5)

				and 23 emergency brakes (accel:4, decel:5)
-	-	5	4	Most of the combination has 1 collision and brakes
-	-	10	4	Most of the combination has 1 collision and brakes

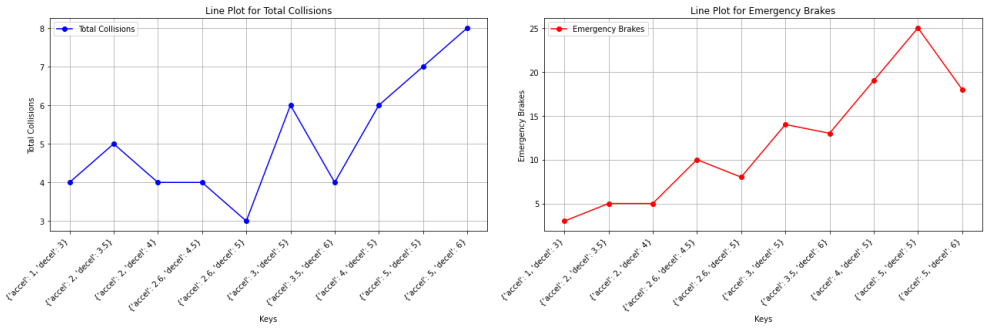


Figure 6 Total collisions and emergency brakes at sigmaerror=0.5, tau=0.1, jmRedspeed=5, jmRedtime=3

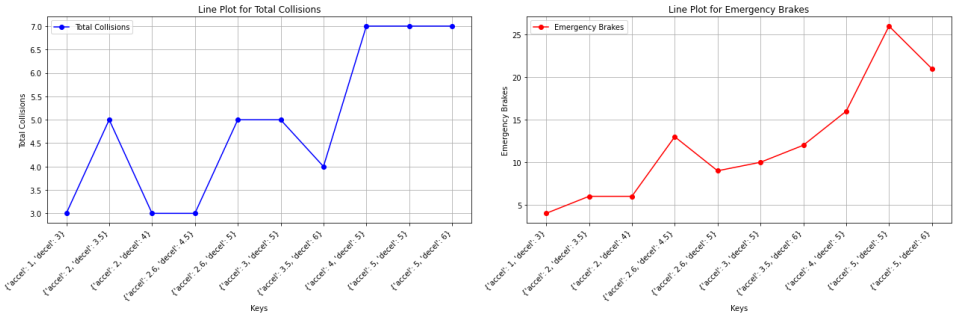


Figure 7 Total collisions and emergency brakes at sigmaerror=0.5, tau=0.1, jmRedspeed=5, jmRedtime=4

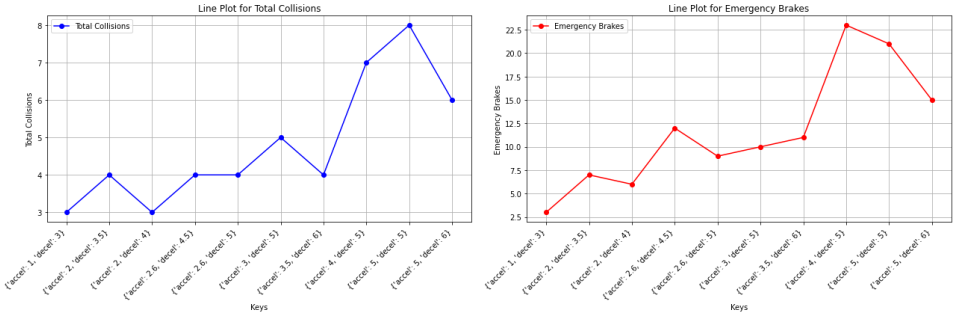


Figure 8 Total collisions and emergency brakes at sigmaerror=0.5, tau=0.1, jmRedspeed=10, jmRedtime=4

1.7 Checking jmDriveAfterYellowTime:

To check the effect following parameters were used:

maxSpeed = 41.67 m/s, emergencyDecel = decel+2, tau = 0.1, sigmaerror = 0.5, jmDriveAfterYellowTime: 4 s.

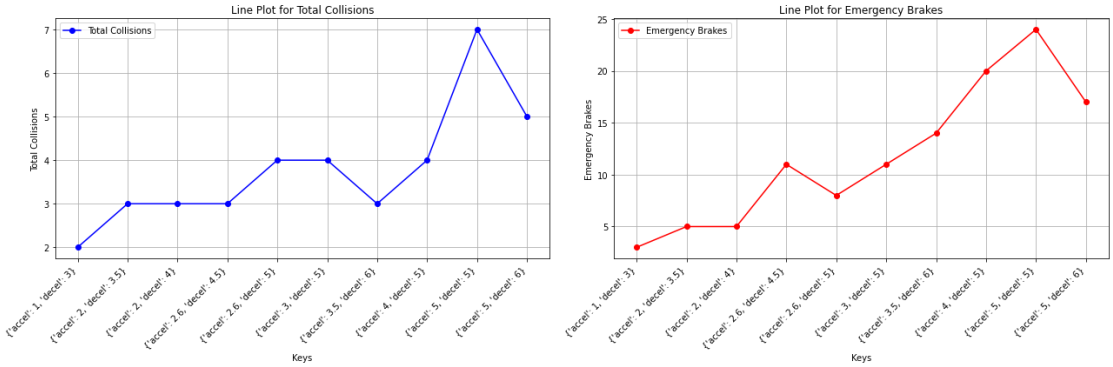


Figure 9 Total collisions and emergency brakes at jmyellowtime=4

1.8 Checking minGap:

tau = 0.1, sigmaerror = 0.5, minGap = 1	8 collisions at (accel: 5, decel: 5) and 28 brakes at (accel: 5, decel: 6)
tau = 0.1, sigmaerror = 0.5, minGap = 2	Increasing trend of collisions and brakes with increase in accel and decel values can be seen
tau = 0.1, sigmaerror = 0.5, minGap = 1, jmDriveAfterYellowTime: 4	8 collisions at (accel: 5, decel: 5) sporty and 5 collisions at (accel: 2.6, decel: 4.5) normal
tau = 0.1, sigmaerror = 0.5, minGap = 1, jmDriveRedSpeed: 5 and jmDriveAfterRedTime: 3	8 collisions at (accel: 4, decel: 5), (accel: 5, decel: 6) sporty and 5 collisions at (accel: 3, decel: 4.5) normal
tau = 0.1, sigmaerror = 0.5, minGap = 1, jmDriveRedSpeed: 10 and jmDriveAfterRedTime: 4	Maximum of 10 collisions seen at (accel: 4, decel: 5) and 28 brakes at (accel: 5, decel: 6)
tau = 1.5, sigmaerror = 0.1, minGap = 1	1 collision at (accel: 1, decel: 3) and emergency brakes at all accel and decel
tau = 1.5, sigmaerror = 0.1, minGap = 2.5	0 collisions, most of accel and decel values have 1 emergency brake warning
tau = 1.5, sigmaerror = 0.1, minGap = 5	0 collisions, most of accel and decel values have 1 emergency brake warning

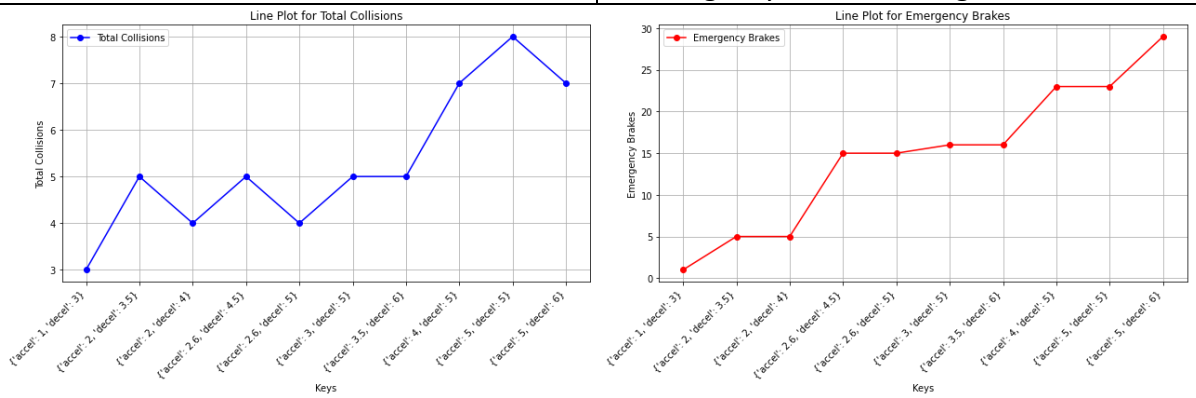


Figure 10 Total collisions and emergency brakes at tau = 0.1, sigmaerror = 0.5, minGap = 1

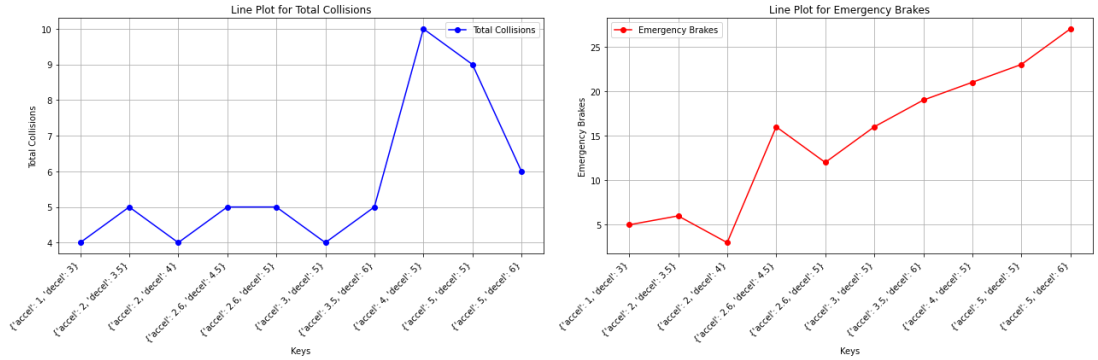


Figure 11 Total collisions and emergency brakes at tau = 0.1, sigmaerror = 0.5, minGap = 1,jmDriveRedSpeed: 10 and jmDriveAfterRedTime: 4

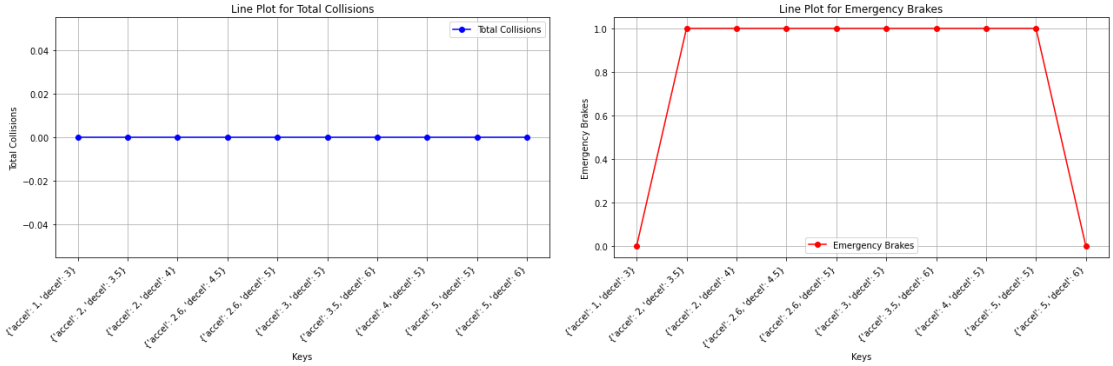


Figure 12 Total collisions and emergency brakes at tau = 1.5, sigmaerror = 0.1, minGap = 2.5

1.9 Checking lcCooperative and lcSpeedGain:

tau = 1.5, sigmaerror = 0.1, lcSpeedGain = 5, lcCooperative = 0	No collisions were observed. All the combinations resulted in 1 only emergency brake warning. This setting is safe
tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 5, lcCooperative = 0	Maximum of 6 collisions and 22 emergency brake warning was encountered. 5 collisions were also seen at normal vehicle settings (accel:3 and decel:5)
tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 5, lcCooperative = -1	Maximum of 5 collisions at (accel:2.6 and decel:4.5) (accel:4 and decel:5) (accel:5 and decel:5). 28 brakes were seen at (accel:5 and decel:5).
tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 10, lcCooperative = 0	Max of 6 collisions and 28 emergency brake warnings were encountered at higher accel and decel values.
tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 10, lcCooperative = -1	7 collisions observed at (accel:5 and decel:5) (accel:5 and decel:6).

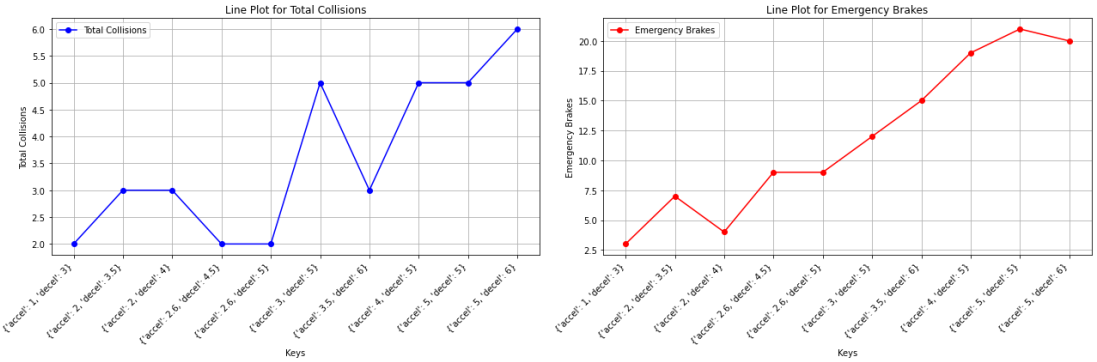


Figure 13 Total collisions and emergency brakes at tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 5, lcCooperative = 0

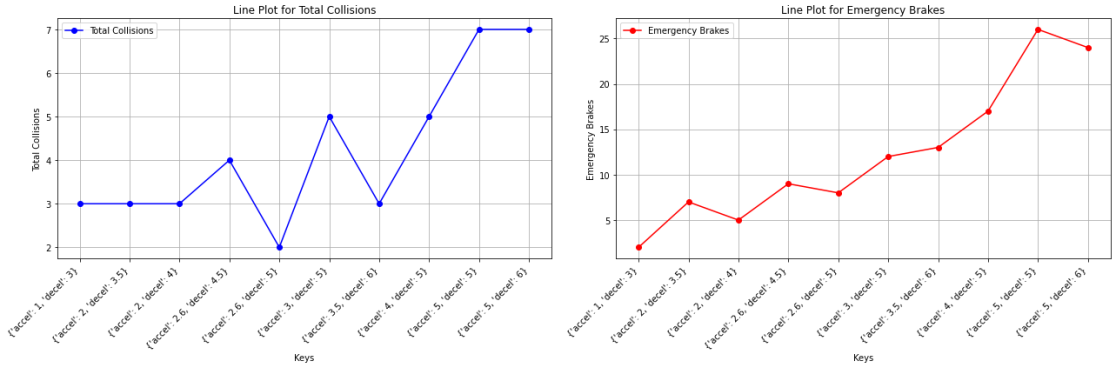


Figure 14 Total collisions and emergency brakes at tau = 0.1, sigmaerror = 0.5, lcSpeedGain = 10, lcCooperative = -1

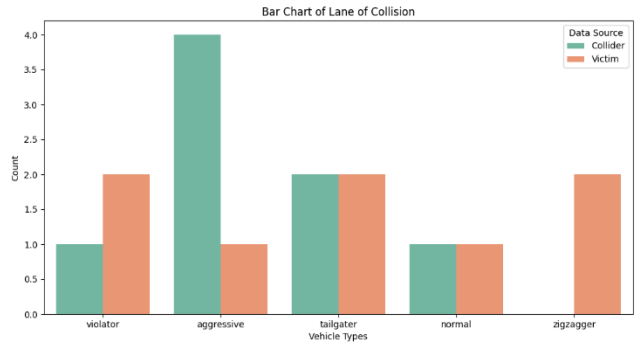
EXP 2: Vehicle Type Interaction

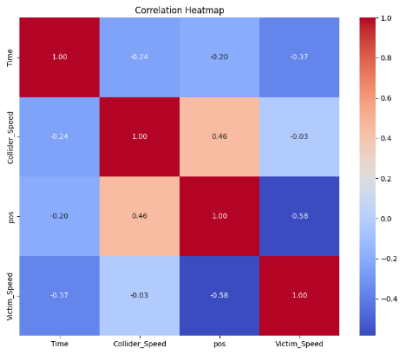
Based on EXP1: Parameter Impact and Their Collaborative Dynamics, I decided 7 driver/vehicle types.

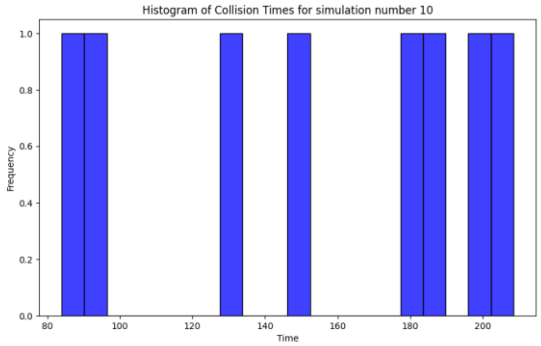
Parameters/vtype	Aggressive	Normal	Passive	Speeder	Tailgater	Violator	Zigzagger
maxSpeed (m/s)(kpmh)	41.67 (150)	33.33 (120)	8.33 (30)	41.67 (150)	33.33 (120)	33.33 (120)	33.33 (120)
accel (m/s2)	5	2.6	1	5	3	3	3
decel (m/s2)	5	4.5	3	6	5	5	5
emergencyDecel (m/s2)	decel+2	decel+0	decel+0	decel+0	decel+2	decel+2	decel+2
tau	0.1	1.5	1.5	1.5	0.1	0.1	0.1
Sigmaerror	0.5	0.1	0.1	0.1	0.5	0.5	0.5
minGap (m)	1	2.5	5	2.5	1	1	1
jmDriveAfterRedSpeed (m/s)	10	-	-	-	-	10	-
jmDriveRedTime (s)	4	-	-	-	-	4	-
jmDriveAfterYellowTime (m/s)	4	-	-	-	-	4	-
lcCooperative	-1	-	-	-	-	-	-1
lcSpeedGain	10	-	-	-	-	-	10

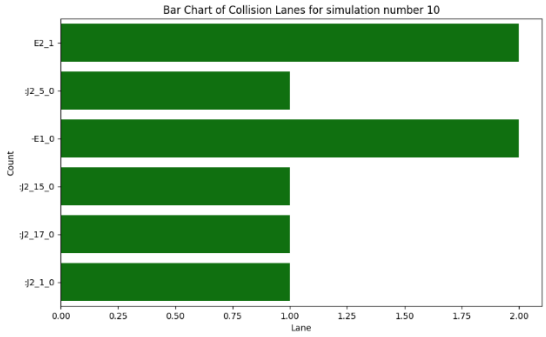
Results:

The maximum number of accidents were caused by aggressive vehicles for simulation number 10. Tailgater, violator, and zigzagger had the maximum number of victims. Maximum collisions happened in 180 to 200 sec.









mean	std	min	max	Lower Q	Upper Q	Median
5.6	2.17	2	8	4.5	7	6.5

The data collected from 10 simulation runs reveals valuable insights about collision counts. On average, there are approximately 5.6 collisions, with the median value being 6.5. This suggests that the majority of runs tend to cluster around this median value. However, there is notable variability in the data, as indicated by the standard deviation of 2.17, signifying that the collision counts can deviate from the average by approximately 2.17. The range of collision counts spans from a minimum of 2 to a maximum of 8, highlighting the full spectrum of possible outcomes.

References:

1. Bokare, P. S., & Maurya, A. K. (2017). Acceleration-deceleration behaviour of various vehicle types. *Transportation research procedia*, *25*, 4733-4749.
2. Ramireddy, S., Ala, V., Ravishankar, K. V. R., & Mehar, A. (2021). Acceleration and deceleration rates of various vehicle categories at signalized intersections in mixed traffic conditions. *Periodica Polytechnica Transportation Engineering*, *49*(4), 324-332.
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